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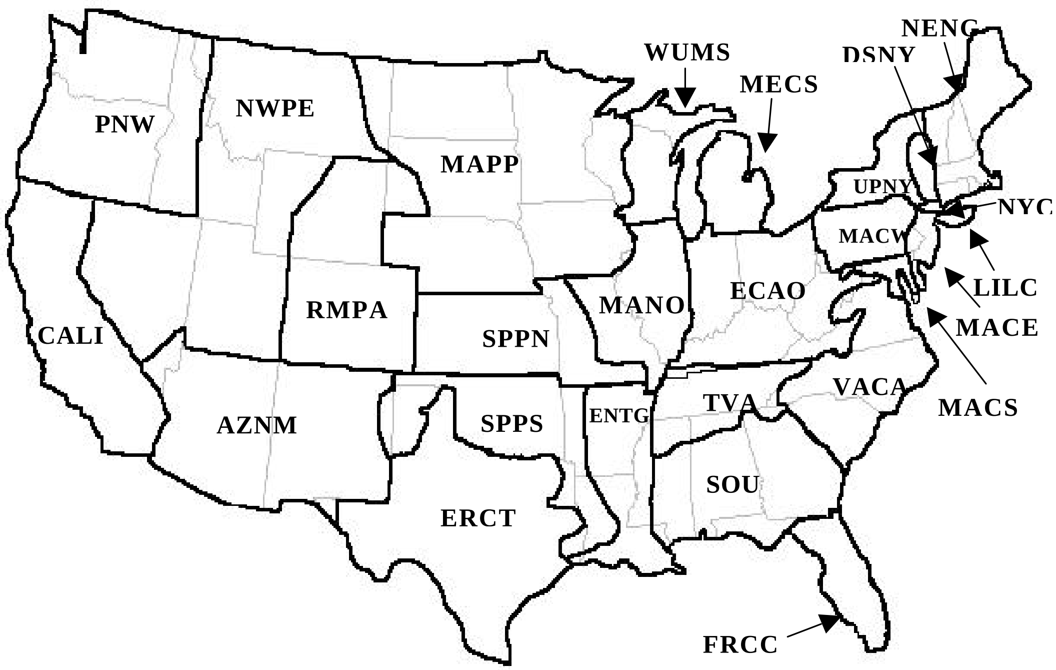
Documentation of EPA Modeling Applications (V.2.1) Using the Integrated Planning Model



CLEAN AIR
MARKET PROGRAMS

Cover: “Version 2.1" in the report title refers to EPA Base Case 2000 and associated policy cases that were developed, tested, and deployed in 2000-2002 using the Integrated Planning Model. Version 2.1 represents a major update and enhancement of the assumptions, inputs, and capabilities of the EPA base case and associated policy cases, which are used in the IPM to project the impact of environmental policies on the electric power sector in the 48 contiguous states and the District of Columbia. The map appearing on the cover shows the 26 model regions used to characterize the operation of the U.S. electric power system in EPA Base Case 2000 and associated policy cases. IPM was developed by ICF Resources, Inc and is used in support of its public and private sector clients. IPM® is a registered trademark of ICF Resources, Inc.

Documentation of
EPA Modeling Applications (V.2.1)
Using the Integrated Planning Model

A draft documentation report,
publicly released in conjunction with the peer review of version 2.1 of
EPA's application of the Integrated Planning Model.

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Table of Contents

1 Introduction

This document describes the nature, structure, and capabilities of the Integrated Planning Model (IPM) and the assumptions underlying the base case (designated EPA Base Case 2000) that was developed for the U.S. Environmental Protection Agency (EPA) by ICF Consulting, Inc. IPM is a multi-regional, dynamic, deterministic linear programming model of the U.S. electric power sector. It provides forecasts of least-cost capacity expansion, electricity dispatch, and emission control strategies for meeting energy demand and environmental, transmission, dispatch, and reliability constraints. IPM can be used to evaluate the cost and emissions impacts of proposed policies to limit emissions of sulfur dioxide (SO_2), nitrogen oxides (NO_X) , carbon dioxide (CO_2), and mercury (Hg) from the electric power sector.

EPA Base Case 2000 serves as the starting point against which policy scenarios are compared. It is a projection of electricity sector activity that takes into account only those Federal and state air emission laws and regulations whose provisions were either in effect or enacted and clearly delineated. (Chapter 3 includes a detailed discussion of the environmental regulations covered in EPA Base Case 2000.) Many regulations mandated under the Clean Air Act Amendments of 1990 (CAAA), but whose provisions have not yet been finalized, were not included in the base case. These include.

- *Ozone and Particulate Matter Standards:* Under Sections 108 and 109 of the CAAA, EPA promulgated National Ambient Air Quality Standards (NAAQS) for ozone (8-hour standard of 0.08 ppm) and fine particles (24-hour average of 65 $\mu g/m^3$ or less and annual mean of 15 $\mu g/m^3$ for particles of diameter 2.5 micrometers or less, i.e., PM 2.5) on July 17, 1997. These standards were overturned by the U.S. Court of Appeals on May 14, 1999. On February 27, 2001 the U.S. Supreme Court upheld EPA's authority to set these standards, but remanded them back to the U.S. Court of Appeals, which scheduled briefings from industry and environmental plaintiffs in November- December 2001.

- *Mercury Regulations on Electric Steam Generating Units:* Under Section 112 of the CAAA, which requires EPA to develop national emission standards for hazardous air pollutants (NESHAP), the agency issued a regulatory finding on December 14, 2000 "that coal- and oil-fired electric utility steam generating units are significant emitters of HAP, including mercury . . ., and . . .that regulation of HAP emissions from coal- and oil-fired utility steam generating units . . . is appropriate and necessary." That finding triggers a requirement for EPA to propose technology-based "Maximum Achievable Control Technology" (MACT) standards for mercury emissions. The mercury MACT standards are scheduled to be proposed by December 15, 2003 and promulgated by December 15, 2004.

- *Regional Haze:* On July 1, 1999, EPA issued Regional Haze Regulations to meet the national goal for visibility established in Section 169A of the CAAA, which calls for "prevention of any future, and the remedying of any existing, impairment of visibility in Class I areas [156 national parks and wilderness areas], which impairment results from manmade air pollution." The regulations require states to submit revised State Implementation Plans (SIPs) that include (1) goals for improving visibility in Class I areas on the 20% worst days and allowing no degradation on the 20% best days and (2) assessments and plans for achieving Best Available Retrofit Technology (BART) emission targets for sources placed in operation between 1962-1977. The revised SIPs are expected to be due between 2004-2006 for areas designated as "attainment" and "unclassified" and between 2006-2008 for "nonattainment" areas. Revised goals and strategies are due in 2018 and every 10 years thereafter until the visibility goal is met.

Had the specific provisions of these regulations been definitive enough to include in EPA Base Case 2000, they would have altered the resulting electricity generation mix and emission projections.

In effect, EPA Base Case 2000 offers a 20-year snapshot of the electric sector assuming that the only future environmental regulations are those whose provisions were definitively known at the end of year 2000. While not an accurate reflection of what will actually occur, this simplifying assumption ensures that the base case is policy neutral with respect to prospective, future environmental policies.

Table 1-1 lists the types of plants included in the EPA Base Case 2000. Table 1-2 lists the emissions control technologies available for meeting emission limits.

Table 1.1. Plant Types in EPA Base Case 2000

<table>
<tr><th>Fossil Fuel Fired</th><th>Renewables
and Non-Conventional Technologies</th></tr>
<tr><td>Coal steam
Oil/gas steam
Combustion turbine
Combined-cycle combustion turbine
Integrated gasification combined-cycle (IGCC) coal
Cogeneration units
Repowered units</td><td rowspan="3">Hydropower
Pumped storage
Biomass IGCC
Wind
Fuel cells
Solar photovoltaics
Solar thermal
Geothermal
Landfill gas
Other[1]</td></tr>
<tr><td>Non-Fossil Fuel Fired</td></tr>
<tr><td>Nuclear</td></tr>
</table>

[1]Includes fossil and non-fossil waste plants.

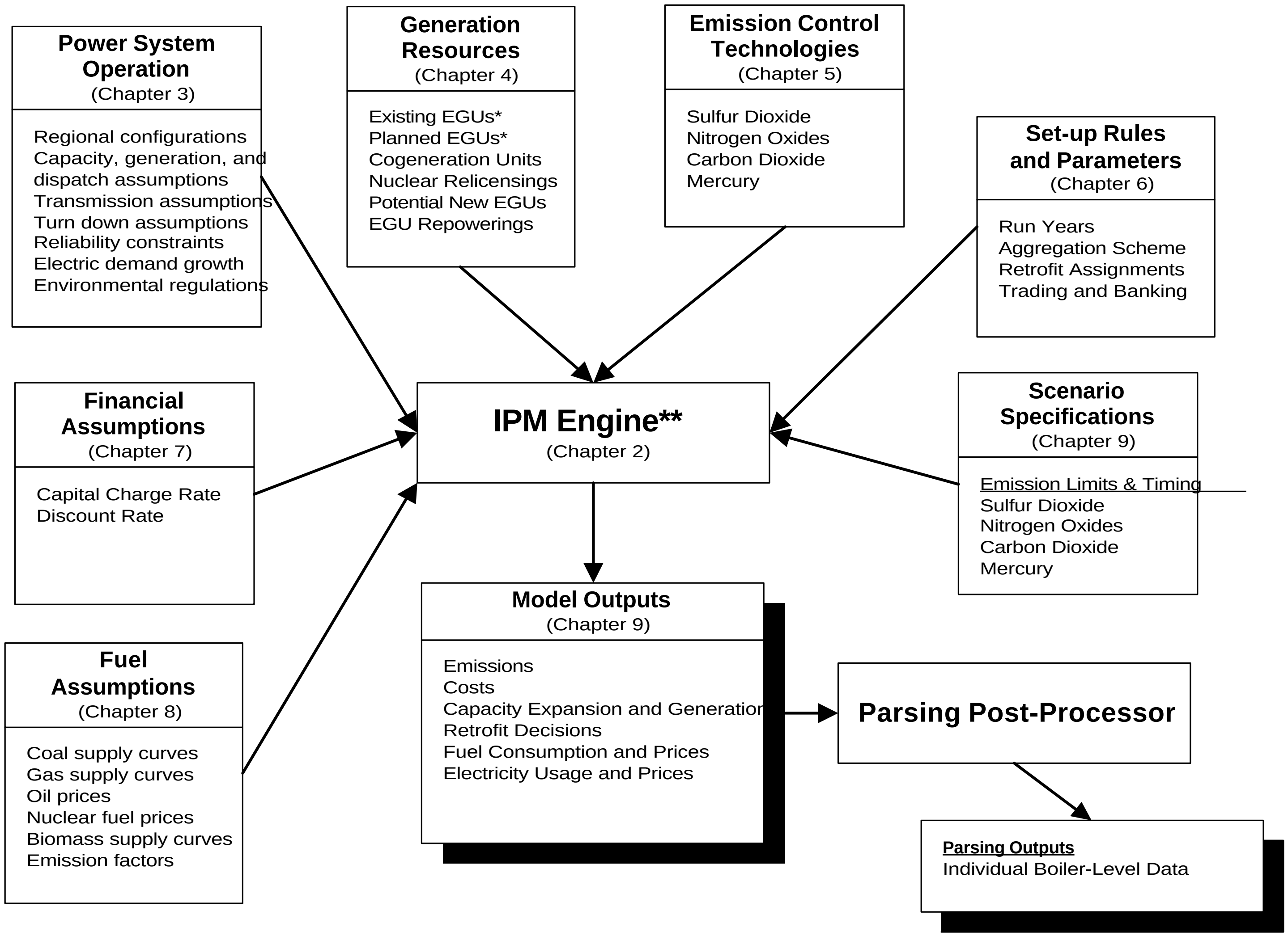
Table 1.2. Emission Control Technologies in EPA Base Case 2000[1]

Sulfur Dioxide (SO_2)	Nitrogen Oxides (NO_X)
Limestone Forced Oxidation (LSFO) Lime Spray Dryer (LSD) Magnesium Enhanced Lime (MEL)	Combustion controls Gas reburn Selective catalytic reduction (SCR) Selective non-catalytic reduction (SNCR)
Mercury (Hg)	**Other**[2]
Combinations of SO_2, NO_x, and particulate control technologies Activated carbon injection[3]	Combustion optimization[3] Biomass cofiring[3]

Notes
[1]Fuel switching between coal types and to natural gas is also a compliance option for reducing emissions in EPA Base Case 2000.
[2]Listed under "Other" are combustion optimization, which can be used to reduce both carbon dioxide and nitrogen oxides, and biomass cofiring which results in a net reduction of carbon dioxide emissions.
[3]Activated carbon injection, combustion optimization, and biomass cofiring are not implemented in EPA Base Case 2000, but are available capabilities that can be implemented, as applicable, in policy runs built on the base case.

Figure 1.1 provides a schematic of the components of the modeling and data structure used for EPA Base Case 2000. This report devotes a separate chapter to each component shown in Figure 1.1. Chapter 2 provides an overview of IPM's modeling framework (sometimes referred to as the "IPM Engine"), highlighting the mathematical structure, notable features of the model, programming elements, and model inputs and outputs. The remaining seven chapters are devoted to different aspects of EPA Base Case 2000. Chapter 3 covers the power system operating characteristics captured in EPA Base Case 2000. Chapter 4 explores the characterization of electric generation resources. Chapter 5 focuses on assumptions regarding emission control technologies. Chapter 6 describes certain set-up rules and parameters employed in EPA Base Case 2000. Chapter 7 summarizes the base case financial assumptions. Chapter 8 presents the assumptions regarding the cost and supply of fuels and emission factors associated with different fuels. Chapter 9, the final chapter of this report, presents the emission caps and timing specifications defining the base case and discusses base case results.

Figure 1.1. Modeling and Data Structure for U.S. EPA Base Case 2000



Notes

*Information on existing and planned electric generating units (EGUs) is contained in the National Electrical Energy Data System (NEEDS) data base developed for EPA by ICF Consulting, Inc. Planned EGUs are those which were under construction or had obtained financing at the time that EPA Base Case 2000 was finalized.

**IPM Engine is the model structure described in Chapter 2.